3. WORK PROGRAMME

3.1 Research Projects

3.1.1 Title

A Time of Flight System for the H1 Experiment at HERA Upgraded for High Luminosity

3.1.2 Objectives

The HERA electron-proton collider at DESY Laboratory in Hamburg will be upgraded for higher luminosity (intensity) in the year 2000. The aim is to improve the accuracy with which the short distance structure of matter is probed through the interactions of electrons (positrons) with protons. The measurements which are possible (at the highest momentum transfer) are unique, and may well reveal unexpected new phenomena in the form of anomalous interaction cross sections compared with the expectations of "Standard Model physics".

Any new discoveries at HERA require first the most efficient possible triggering to eliminate background interactions which would otherwise flood the recorded event rate, and second the most accurately determined interaction cross sections. Of paramount importance in the high luminosity of HERA is the availability of time-of-flight signals both close to and away from the *ep* interaction region. These signals then form the basis of eliminating background at the earliest possible moment in the trigger scheme (Level 1). They also determine the accuracy with which the time structure of protons in the HERA bunches is monitored, thereby providing the essential "timing measurements" for the most accurate determination of the HERA luminosity in the electron-proton interaction region.

This proposal requests funding for three NIS groups of the H1 experiment to ensure their participation in this time-of-flight project.

The aims of the project are

1. to establish the system of ToF detectors, both in the improvements to present detectors, electronics and data acquisition, and the installation of new detectors, electronics and data acquisition,

2. to commission, calibrate and monitor the system for Level 1 on-line use and for off-line use,

3. to develop the off-line analysis codes for the best possible exploitation of ToF data, and thereby for the most accurate measurements of *ep* interaction cross sections.

3.1.3 Background & Justification for Undertaking the Project

The H1 experiment is one of the detectors built around the interaction regions of the electron (positron)-proton storage ring HERA at the DESY laboratory in Hamburg, Germany. It is designed to provide nearly hermetic coverage so that the best possible identification and the precise measurement of electrons, muons and penetrating neutral particles, together with the accurate measurement of jets with high particle densities, is achieved. For this, use is made of finely segmented calorimeter detectors and precision tracking detectors.

The *ep* interaction energy at HERA is an order of magnitude larger than in previous lepton-proton scattering experiments. It thus has become possible to probe the structure of *ep* interactions with new precision in interactions with large momentum transfer. Measurements of the structure of the proton and the photon have been achieved in new kinematic regions. As a result our understanding of this structure in terms of Quantum Chromodynamics (QCD) has been greatly extended. The first precision measurements of the structure of the interaction mechanism of protons with other hadrons have led the way in the application of QCD to understand the mechanisms responsible for the bulk of such interactions in which no "hard scale" exists. At the highest momentum transfer it has been possible to see first evidence for the space-like structure of electron-quark and positron-quark interactions, and thereby to start to probe the structure of the electroweak (EW) sector of the Standard Model in such interactions.

Since first data taking in 1992 HERA has delivered integrated luminosity of about *50* pb^{-1} to the H1 experiment, and by May 2000 ~*80* pb^{-1} is expected. Many important new results have been reported with these accumulated data. The precision and scope of these results are unique, and, together with the symbiosis of QCD theory, continue to guide the development of our understanding of the hadronic sector of the Standard Model (SM). Such measurements are now moving to levels of experimental precision for which our understanding of the performance of the experimental equipment dominate and must be further improved, and it is necessary to provide faster, more powerful, triggering of the experiment. With the presently available data, it has only been possible to "sniff" at the *ep* interactions which probe the shortest possible distance scales, i.e. with highest momentum transfer.

The above brief outline of the status of HERA physics amply motivates the work now in progress to upgrade both the HERA luminosity and the H1 experiment. The intention is to exploit the four times increase in *ep* luminosity at HERA from 2001

- to greatly enhance the sensitivity to new physics at the highest momentum transfers,
- to obtain more event samples of a more exclusive nature, and therefore with lower cross sections, throughout the kinematically accessible range of momentum transfer, e.g. heavy flavour production,
- to run HERA for short periods at different centre of mass energies to measure for example longitudinal structure functions and investigate the kinematic dependence of interesting new effects.

HERA will be upgraded in the period from May 2000 to February 2001. The luminosity increase is being achieved by means of dual function magnets which are added to the HERA lattice and which are positioned close to the *ep* interaction region. These magnets protrude to well within the volume of the H1 experiment, as such pose new challenges to efficient triggering and background rejection, and are a source of additional background in detectors in the H1 experiment, especially those close to the stored beams and adjunct magnets.

The new experimental challenges are being met by a major upgrade of the H1 experiment. The upgrade includes both improvements to present detector systems, for example increased spatial segmentation of triggers, and new detectors, for example new drift chambers in the Forward Track Detector, new silicon detectors, and new electromagnetic shower detectors for luminosity measurement.

An essential improvement in H1 for operation at high luminosity is a greatly enhanced Time of Flight (ToF) system (see Fig.1). ToF is one of the key components of the H1 experiment. Its main purpose is to identify quickly events which do not originate from *ep* interactions. The main sources of such background interactions are proton interactions with the residual gas in the beam pipe, and stray protons which produce particle showers by hitting the beam tube and other devices around the accelerator. The signals provided by the ToF system are used in the first level (L1) trigger decision. They ensure efficient rejection of such background by means of combinations of individual ToF measurements which are incompatible with particle production from the *ep* interaction vertex. These signals are available very early in the time development of the trigger procedure, and therefore they can be used for efficient data taking. In the present set-up the ToF system is based on the fast plastic scintillators and consists of six ToF detectors.

The proposed ToF system will include a number of new detectors to increase the number of timing measurements within the volume of the H1 experiment and to increase the spatial segmentation of present ToF detectors. The latter is necessary because it is intended to use the ToF system also as an active component in some L1 triggers to provide segmented information on the direction of particle flow. This will extend the kinematic range of good *ep* vertex determination at L1 well into the "forward" direction, that is the direction of the stored proton beam. Such a feature is essential if the triggering of very high Q^2 neutral and charged current *ep* interactions is not to be overwhelmed by background.

A time resolution of less than 1ns is necessary, first, to resolve whether the *ep* interaction occurs within the well defined bunch timing window (specified by the HERA r.f.), leading to the accurate evaluation of event rates, and, second, to resolve the substructure of the proton bunches (so called satellite bunches) which is important in precise measurement of the luminosity. Thus an efficient ToF system is essential for accurate determination of the event rates and the luminosity.

The H1 experiment is operated by an international collaboration consisting of 39 institutes from 13 countries. The institutes and individuals participating in this proposal have been involved in the past and at present on the development and operation of the ToF system measurements of H1. This proposal will be realized by the groups from following institutions of the H1 Collaboration: University of Dortmund (UD, Germany), Rutherford Appleton Laboratory (RAL, UK), University of Liverpool (UL, UK), Yerevan Physics Institute (YerPhI, Armenia), Institute of Theoretical and Experimental Physics, Moscow (ITEP, Russia) and Joint Institute for Nuclear Research, Dubna (JINR, Russia).

The groups associated with this proposal have agreed to take full responsibility within the H1 Collaboration at HERA for all aspects of the new H1 ToF system under the leadership of the group from the Yerevan Physics Institute.

3.1.4 Scientific/Technical Description

3.1.4.1 RESEARCH PROGRAMME

The new H1 ToF system is shown in Figure 1. The system is based on fast plastic scintillators which must be radiation resistant, and read out by photodetectors which must operate in high magnetic field within the severe spatial restrictions of the H1 detector.

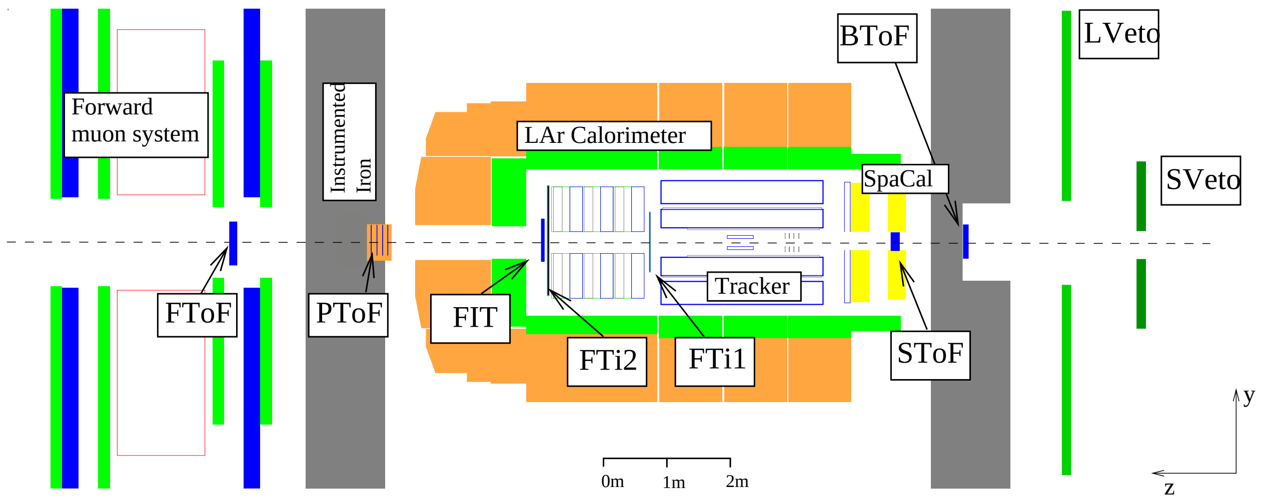

Figure 1. The schematic arrangement of ToF detectors in the H1 experiment - side elevation; electrons/positrons are incident from the left, protons from the right and the interactions occur at the center of the central track detector ("Tracker") of the experiment.

The upgrade of HERA and the installation of the high luminosity magnets means that those detectors presently operational in H1 have to undergo at least substantial refurbishment, and the opportunity will be taken also to improve very significantly their functionality. In addition, new detectors are proposed. The ToF electronics system must be renewed because of the increased number of readout channels, because of the upgrade of other H1 detectors which share common elements and/or readout branches with the ToF system, and because of the requirement of improved timing resolution. New software is required for the read-out, monitoring and control, calibration and off-line analysis.

DETECTOR	FToF	PToF	FIT	FTI_2	FTI_1	BToF	SToF	LVeto	SVeto
Distance from inter. point (m)	7.0	5.0	2.7	2.5	1.3	-3.3	-4.0	-6.5	-8.1
Number of channels	4	8	8	32	16	8	8	20	8
Number of planes	2	2	2	1	1	2	2	2	2
Inner/Outer Dimensions (cm)	7 / 34	7 / 30	7 / 25	46 / 170	24 / 90	7 / 25	7 / 18	7 / 430	7 / 104
Type	Scint., PMT	Scint., WLS, PMT	Scint., PMT	Scint., WLS, PMT HPD	Scint., WLS, PMT, HPD	Scint., PMT	Scint., PMT	Scint., PMT	Scint., PMT

Table 1. General characteristics of ToF detectors.

The proposed individual detectors are listed below together with the work for each to be operational in H1.

1. FToF:

The Forward ToF detector (FToF) is designed to distinguish background events from genuine *ep* interactions in the L1 trigger. The detector also provides measurement of the time profile of proton bunches which is used for more accurate determination of HERA luminosity. Because of the new HERA magnets the existing FToF has to be replaced. The present location is no longer available. A new location has to be found between the new magnets within the forward muon system. Design work is necessary to establish the optimal "2π" azimuthal coverage within the available space. The operation of phototubes close to the new magnets and their fringe field have to be established.

2. PToF:

Because of the new HERA magnets, the existing PLUG detector has to be replaced. The new PLUG ToF detector (PToF) is designed to "tag" the presence of forward energy deposition with good timing resolution. For better control of the signal threshold, four analog readout channels are foreseen for the PToF system. Because rather high radiation doses are expected in the PToF area, scintillator layers must be radiation resistant. The photodetectors must be operable in the magnetic field of the H1 solenoid magnet (1 Tesla).

3. FIT:

The Forward Inner ToF detector (FIT) is designed, similar to FToF, for independent background rejection and to provide time measurements of the proton beam structure. The support for the FIT system has to be reconfigured because of the modifications concerned with the upgrade of the Forward Track Detector which sits immediately in front of it. The present 8 channels of data have to be incorporated into the new ToF electronics and Data Acquisition (DAQ) system.

4. FTi1 and FTi2:

The Forward ToF_{inner1} (FTi1) and Forward ToF_{inner2} (FTi2) detectors together constitute a new scintillator "telescope" for timing and triggering of events with forward particle production. They "sandwich" the new H1 Forward Track Detector. Their purpose is to ensure that event vertex information is available at trigger L1, and to provide a further means of rejecting background production at small forward angles. The topological configuration will be one plane of 16 counters subdivided into 8 segments in azimuth arranged radially in 2 rings. This segmentation matches the trigger granularity in the Lar calorimeter in the forward region.

The information from forward ToF detectors FToF, PToF, FIT and FTi1,2 are used also in selection criteria of physics events.

5. SToF:

The presence of the new HERA magnets requires that the inner aperture of the SpaCal calorimeter is increased, thereby reducing its angular coverage and removing important timing information close to the beam pipe. It is therefore necessary to install a new ToF scintillator detector SToF optimized to fill in the available space after the removal of inner SpaCal modules. ToF signals must be handled in both the SpaCal and the ToF subsystems. SpaCal phototubes from the removed modules will be used.

6. BToF:

In the region between the H1 instrumented iron and the endbox of the HERA magnet, which sits within the SpaCal and instrumented iron, a new backward ToF (BToF) will be installed. Two planes of scintillator are planned, with a 4-fold spatial segmentation for each plane. SToF and BToF will provide background rejection upstream of the proton beam direction from the interaction point.

7. LARGE VETOWALL:

The large veto wall (LVeto) is a system of scintillator counters for which no modifications are necessary for the detectors, phototubes, supports, and read-out. The system has to be dismounted for the installation of the new HERA magnet lattice and then remounted . The *20* channels of this detector have to be integrated into the new electronics system for all ToF detectors.

8. SMALL VETOWALL:

The small vetowall (SVeto) consists of 8 scintillator counters and it geometrically overlaps LVeto. The SVeto and LVeto walls together cover nearly the entire backward surface of the H1 detector and provide time separation between the background of the passing proton bunch and *ep* event correlated activity. Because of installation of new HERA magnets the small vetowall (SVeto) has to be moved to a new position close to the beam-line in the backward region. A new design of SVeto is required.

The tasks necessary to achieve the new ToF system are identified as:
T1. Preparatory work
T2. Establishment and operation of different detectors and electronics using prototypes in H1 environment
T3. Final design, manufacturing and testing of detectors and the electronics
T4. Software development for DAQ, monitoring and components calibration
T5. Installation and integration of the ToF system into H1
T6. Commissioning of the ToF system in H1 data taking
T7. Development of ToF off-line data analysis and integration into physics analysis

T1: Preparatory work

The task is aimed at obtaining an exact understanding of the full impact of HERA and H1 upgrade programs on the ToF system, e.g. space available for the ToF detectors, modifications of the H1 Central trigger logic and DAQ, software modifications etc. The task will be achieved by means of communications and/or co-ordination meeting of the project teams together with responsible experts and departments. The output of this task forms the background for the further development and progress of proposed program in its basic aspects, namely:
a) detector - hardware design including mechanical support structures
b) electronics - design and prototyping
c) software - detector simulation and necessary modifications
Task is taken by all participating teams.
Coordinating team is YerPhI.
Schedule: months 1-2.

T2. Establishment and operation of different detectors and electronics using prototypes in the H1 environment

The task is aimed at performing the necessary investigations on prototyping and *R&D* studies of the ToF system both for detector performance and electronics. The fulfillment of the task is foreseen in the light of investigations performed in the first stage of the program; T1. Work program includes all specifications and modifications mentioned in detector list above. Project teams foresee a further sub-division of the task:

T2.1: Prototyping of FToF, FIT, BToF, SVeto will be by YerPhI team

Test studies on efficiency of scintillating light collection using light guides based on optical fibers. Studies on PMT magnetic shieldings.

T2.2: Prototyping of FTi1 and FTi2 systems will be by RAL and UL

The following investigations are foreseen:
o - Monte-Carlo studies of light collection for various detector geometries and readout methods
o - investigate properties of new hybrid photodetectors and their application in the H1 environment
o - design and develop low noise charge sensitive pre-amplifier
o - construct and test prototype detectors including a full simulation of the electronics chain
o - optimize all aspects of system noise

T2.3: Prototyping of SToF will be by ITEP

Test studies on efficiency of the light collection from large area scintillators in the condition of very limited space for light guides.

T2.4: Prototyping of PToF will by JINR team

R&D studies to select radiation hard plastic scintillators, optimize light collection via wave length shifting fibers in very limited space, select photo-multiplier tubes resistant to magnetic field and test time resolution of the proposed detector.

T2.5: Prototyping of all ToF electronics:

The aim of this sub-task is prototyping of new electronics components to provide reliable maintenance of increased ToF channel set with a higher time resolution. Prototypes are designed and manufactured as well as tested. Main components of electronics design include:
o - multichannel Constant Fraction Discriminator with time jitter level ~100ps

o - Programmable Delay Units allowing ToF signal adjustment in Interaction, Background and Global gates, based on new high precision programmable delay chips
o - trigger pipe-line units designed to deliver ToF signals, adjusted in time and BC (bunch-crossing), to the Central Trigger logic
o - Field Programmed Gate Arrays based strobe units to provide full logic of the detector schemes
The subtask is undertaken by YerPhI team.
Coordinating institute is YerPhI
Schedule: months 2-4

T3: Final design, manufacturing and testing of detector components and the electronics

The task is aimed at obtaining the final hardware performance of the upgraded ToF detectors following the completion of previous tasks T1 and T2. Subdivision of the task is seen as:
T3.1 Modifications of subdetectors FTOF, FIT, LVeto, BToF, SVeto will be performed by YerPhI
T3.2 Design, manufacturing and testing of FTi1 and FTi2 systems is undertaken by RAL and UL
T3.3 Design, manufacturing and testing of SToF is performed by ITEP
T3.4 Design, manufacturing and testing of PToF is performed by JINR
T3.5 Design, manufacturing and testing of electronics is performed by YerPhI

The task is completed after successful tests of each ToF detector operated with manufactured electronics.
Coordinating institute is YerPhI
Schedule: months 3-10

T4. Software development for DAQ, monitoring and calibration

In the framework of the HERA/H1 general upgrade new strategies are foreseen for ToF data acquisition and on-line monitoring systems and calibration studies. This task is subdivided as follows:

T4.1 Data acquisition

In the present set-up the ToF shares DAQ branches with other H1 detectors (Central Tracking devices). Due to upgrades of these components the strategy of data transfer from the ToF system to the central DAQ has to be redefined. The new ToF system will share read-out either with the Central Trigger or with the backward calorimeter (SpaCal). The more convenient option will be implemented. Updated brunch protocols and software for data distribution are necessary.

T4.2 On-line monitoring and slow-control

New techniques for data transfer from the front-end electronics to the local monitoring system will be explored in order to provide higher capacity and high quality of data monitoring. A Fast Ethernet link is considered for this purpose. The local monitor computer will run modern Internet tools which allow access to this machine remotely via Internet. The new ToF system has to be included in the existing slow-control system. A new system will be created for calibration purposes providing regular checks and control of of high voltages (HV) of PMTs.
UD and YerPhI undertake the task. Coordinating team is UD
Schedule: months 2-20

T5: Installation and integration of the ToF system into H1

The aims of this task are hardware and electronics establishment of the new ToF system in the H1 experiment. The task subdivides into:

T5.1 Detector installation

As soon as all ToF detectors are modified, built, and their operational characteristics are understood, the installation phase of the program must be performed. Detectors will be installed following the schedule for the H1 general upgrade. Task is performed by all participating teams. Coordinating team is YerPhI. The work is finished after final survey, cabling and testing.
Schedule: months 5-11

T5.2 Electronics installation

All manufactured electronic components are installed within the H1 ToF common electronics scheme. The performance of the ToF electronics is integrated into the H1 DAQ. The work is finished after ensuring proper data handling both for on-line monitoring and off-line data readout.
Task is taken over by all project teams. Coordinating institute is YerPhI.
Schedule: months 5-10

T6: Commissioning of the ToF system in H1 data taking

After preliminary investigations of the ToF system using cosmics rays, the final stage of the tuning is realized in H1 operational conditions in the presence of proton and/or electron beams during the optimization of the operation of the H1 detector. Necessary work includes:

o - final installation of detector HV

o - trigger settings

o - data on-line monitoring

o - ToF data acquisition integration into the H1 central DAQ

o - off-line tests of data quality and stability

The work is completed after the full commissioning of the H1 ToF system in luminosity conditions. Task is taken by all participating groups.

Coordinating institute is YerPhI.

Schedule: months 11-14

T7: Development of ToF off-line data analysis and integration into the physics analysis

The new ToF system will lead to significant changes in the existing H1 software packages. The most affected packages are the reconstruction software, the detector simulation code, and some data analysis tools. The increased number of channels requires a review of the existing data structure.

The task subdivides into:

T7.1: Update of H1 detector simulation package

Once the geometrical design of the new ToF system is specified these new detectors can be implemented into the H1 detector simulation. Using this simulation the first expectations of detector response to physics can be computed. This also gives a possibility to study trigger strategies.

T7.2: Updates of H1 reconstruction package and development of analysis tools

The new ToF system leads to necessary changes in the H1 reconstruction package. Since the reconstruction is the basis of all further off-line analysis, this part has highest priority. In order to provide the most efficient data check tools updates and additions to the H1 analysis software packages have to be developed including an upgrade of the luminosity measurement.

T7.3: Off-line data analysis and physics studies

The collected data will be analyzed with developed tools. These studies will focus on following aspects:

o - monitoring of the data quality

o - determination of trigger efficiencies

o - improvement of event selection with ToF on the H1 on-line filter farm

o - comparison of collected data with simulated data

o - investigations of physics event processing and background rejection using ToF information for different event topologies in H1. Here detailed investigations are planned for:

a) diffractive physics, with the help of FToF, PToF, FiT, and FTi detectors installed in forward region

b) use of the ToF detector in precision measurements of the total photoproduction cross section

c) use of the ToF detector in precision measurements of structure functions

d) use of ToF detector in measurements of total and differential cross section measurements in exclusive physics processes (e.g. heavy flavour production) with high backgrounds from other physics processes

o - studies and improvements of systematic uncertainties of cross section measurements in H1 high luminosity running conditions

This task is aimed to achieve the final goals of the new ToF system, namely good quality data taking with possibly high reliability and high efficiency, stability and accuracy. Physics investigations will complete the proposed program.

Task is taken by all project teams.

Schedule: months 2-24.

3.1.4.2 DELIVERABLES, EXPLOITATION & DISSEMINATION OF RESULTS

Two major stages are distinguished in the proposal:

Stage one - first 12 months. At the end of this stage the new ToF system of H1 will become operational. This stage is finished at the very beginning of upgraded HERA luminosity operation and then a report will be given to INTAS summarizing the progress in the first part of the research program and in the commissioning of the proposed new system. Regular status/progress reports will be given in Collaboration Meetings and meetings concerned with technical coordination of H1. The results will be discussed in special meetings of H1. The results obtained will lead to publications in technically oriented international journals (e.g. Nuclear Instruments and Methods).

Stage two - second 12 months. During the second year of projected investigations preliminary results on ToF data off-line analysis will be improved under H1 stable running conditions. The results on H1 specific software studies will lead to H1 internal note publications. The results on luminosity measurement improvements, physics events processing, background rejection criteria will be discussed in and then used by physics working groups of H1. The results of systematic physics studies which use the ToF information will be presented in conferences and published in international refereed journals. The proposed investigations will also form projects for students' diploma and Ph.D. theses. A final report will be sent to INTAS at the end of the project.

3.1.5 Description of the Consortium

3.1.5.1 RESEARCH TEAMS

All teams involved in project have extensive experience in H1 experiment operation, development, data taking and physics analysis. They are experienced with ToF system maintenance in particular.

Team 1 (P1). University of Liverpool, UK

The group from the University of Liverpool has played a central role in many aspects of H1 since its beginning in the mid 1980s. Its particular responsibilities follow from its contribution to the H1 Forward Track Detector (FTD) of radial wire drift chambers and now the upgrade of the FTD. The group is part of the University of Liverpool High Energy Physics group in which there is a very strong technical base for designing, building, and operating large detectors in collaborative experiments. It has also made, and continues to make, major contributions to physics analysis on H1. The Liverpool team includes a young post-doctoral physicist who has hardware experience and is also a Convenor of an H1 Physics Working Group (DM), and a young design engineer (AM) who also is a fully qualified workshop "craftsman" and who was part of the team which designed and constructed the H1 FTD. Task allocations for the team include design, prototyping, construction and commissioning of FTi1 and FTi2 detectors, software investigations and physics analysis (T1, T2.2, T3.2, T4.2, T5, T6, T7).

Scientific official responsible for the project: Prof. J. Dainton

TEAM LIST:

1. J. Dainton
2. D. Milstead (under 35)
3. A. Muir (under 35)

Team 2 (P2). Dortmund University, Germany

Th DU team is currently engaged in the operation and analysis of the liquid argon calorimeter, the SpaCal and the time of flight system of the H1 detector. One of them (DW) has built and run a big time of flight system for the SFM detector at the CERN ISR. Recently members of the team have built a time of flight counter for the H1 detector and have developed the necessary analysis tools. The DU workshop has build scintillation counters for large detectors at CERN (CDHS and NA31 hadron calorimeters) and DESY (ARGUS calorimeter). Task allocation for the group includes simulation work, software development and physics analysis (T1, T3, T4.2, T5.2, T6, T7).

Scientific official responsible for the project: Prof. D. Wegener

TEAM LIST:

1. M. Grewe (under 35)

2. K. Wacker
3. D. Wegener
4. C. Wissing (under 35)

Team 3 (P3). Rutherford Appleton Laboratory, UK

The RAL team is currently engaged in the operation and analysis of the H1 Forward Tracking Detector. The team has experience of building and operating large scintillator based detectors on high energy physics experiments. The RAL group has a large experience in the R&D and production of major detectors for experiments world wide as well as experience in a wide range of technologies, ranging from particle physics to space physics and astronomy. Task allocations for the team include design, prototyping, construction and commissioning of FTi1 and FTi2 detectors, software investigations and physics analysis (T1, T2.2, T3.2, T4.2, T5, T6, T7).

Scientific official responsible for the project: Dr. J. V. Morris

TEAM LIST:
1. D. Clarke
2. J. V. Morris
3. R. Stephenson

Team 4 (P4). Yerevan Physics Institute, Armenia

The YerPhI team is currently involved in the operation and maintenance of the H1 ToF system. The group has large experience with

o - design, construction and operation of scintillator detectors
o - time-of-flight measurements in photo-electronulear processes
o - maintenance of H1 ToF system
o - H1 ToF electronics design and manufacturing
o - software studies in ToF on/off-line data taking
o - analysis in diffractive physics, multijet production studies

Task allocations of the team include modifications of FToF, FIT, BToF, SVeto and LVeto subdetectors, electronics manufacturing for whole ToF system, software investigations and physics analysis (tasks T1 , T2.1, T2.5, T3.1, T3.5, T4, T5.1, T4, T5, T6, T7).

Scientific official responsible for the project: Dr. R. Demirchyan

TEAM LIST:
1. A.Beglarian
2. A.Bunyatiyan (under 35)
3. R.Demirchyan
4. T.Mkrtchyan (under 35)
5. S.Kazarian

Team 5 (P5). Institute for Experimental and Theoretical Physics, Moscow, Russia

The ITEP team has experience in the design and construction of the lead/scintillating SPACAL calorimeter for the H1 experiment. The hadronic part of the calorimeter was made and tested by ITEP in Moscow. The H1 group has also designed, constructed and installed a system of 32 scintillating counters for a measurement of proton remnant in H1 experiment. All counters were made and tested in Moscow. Task allocation for the team includes the design, prototyping, construction and commissioning of SToF detector and software developments.

Scientific official responsible for the project: Dr. V. Efremenko

TEAM LIST:
1. V.Efremenko
2. D.Ozerov (under 35)
3. S.Tchechelnitski (under 35)
4. V.Nagovizin
5. V,Thernyshov
6. I.Varlamov (under 35)

Team 6 (P6). Joint Institute for Nuclear Research, Dubna, Russia

The JINR team is currently involved in the operation and analysis of the H1 Forward Proton Spectrometer and the analysis of the H1 PLUG hadron calorimeter. They have experience in the design, operation and analysis of different detector types for high energy physics: hadron calorimeters, trigger scintillator hodoscopes, fiber detectors with position sensitive photo-multiplier readout, multi-wire proportional chambers, multi-channel gas Cherenkov counters. Task allocation for the team includes design, prototyping, construction and commissioning of the PToF detector as well as software development and physics analysis for the PToF detector (T1, T2.4, T2.5, T3.4, T3.5, T5, T6, T7).

Scientific official responsible for the project: Dr. M. Kapichine

TEAM LIST:

1. M.Kapichine
2. A.Koutov (under 35)
3. A.Morozov
4. V.Panassik (under 35)
5. V.Spaskov

3.1.5.2 SCIENTIFIC REFERENCES

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3.1.6 Management

The progress of the project is closely linked to the technical co-ordination and progress of the H1 experiment. The team leader in the YerPhI will be designated the ToF Coordinator and he will report to the H1 Upgrade Coordinator, the H1 Software Coordinator and the H1 Technical Coordinator. The ToF Coordinator will be responsible for the coordination and completion of all tasks. To ensure success he will convene regular project meetings for which minutes will be produced and posted on the H1 WWW pages. At H1 collaboration meetings progress reports will be given.

The project meetings will take place at DESY, Hamburg and in the institutes of the ToF projects teams. Reports from the project will also be given to other H1 meetings in DESY and other institutes as requested by the H1 Technical, Software and Upgrade Coordinators.

3.1.6.1 PLANNING & TASKS ALLOCATION

Tasks	Participants	Months 1-6	Months 7-12	Months 13-18	Month 19-24
T1	P1, P2, P3, P4, P5, P6				
T2.1	P4				
T2.2	P1, P3				
T2.3	P5				
T2.4	P6				
T2.5	P4				
T3.1	P4				
T3.2	P1, P3				
T3.3	P6				
T3.4	P5				
T3.5	P5				
T4.1	P2, P4				
T4.2	P2, P4				
T5.1	P1, P2, P3, P4, P5, P6				
T5.2	P1, P2, P3, P4, P5, P6				
T6	P1, P2, P3, P4, P5, P6				
T7.1	P1, P2, P3, P4, P5, P6				
T7.2	P1, P2, P3, P4, P5, P6				
T7.3	P1, P2, P3, P4, P5, P6				

3.1.6.2 COST TABLE

MAIN COST TABLE

INTAS MEMBER TEAMS

TEAM NAME	STATUS	COST CATEGORIES						TOTAL
		Labour Costs	Overheads	Travel and subsistence	Consumables	Equipment	Other costs	**Total Euro**
LU	CO		2000	4000				6000
DU	CR			3000				3000
RAL	CR		2000	4000				6000
SUBTOTAL	**(Euro)**		4000	11000				15000

NIS TEAMS

TEAM NAME	STATUS	COST CATEGORIES						TOTAL
		Labour Costs	Overheads	Travel and subsistence	Consumables	Equipment	Other costs	**Total Euro**
YerPhI	CR	25200		4800				30000
ITEP	CR	16000			3000	1000		20000
JINR	CR		1000	23000		1000		25000
SUBTOTAL	**(Euro)**	41200	1000	27800	3000	2000		75000

TOTAL	**(Euro)**	41200	5000	38800	3000	2000		90000

NIS Labour Cost Summary Table

Team Name	Number of individual. grants	Cost/month (Euro)	Number of Months	Total cost (Euro)
YerPhI	1	250	24	6000
	4	200	24	19200
ITEP	1	200	24	4800
	2	170	24	8160
	2	130	12	3120
Totals	10			41200

3.2.7 Summary

The HERA electron-proton collider at DESY Laboratory in Hamburg will be upgraded for higher luminosity in the year 2000. The aim is to improve the accuracy with which the short distance structure of matter is probed through the interactions of electrons (positrons) with protons.

The H1 experiment is a multipurpose detector built around the interaction region of HERA. The new experimental challenges are being met by a major improvement of the H1 experiment in the framework of the HERA upgrade. An essential improvement in H1 for operation at high luminosity is a greatly enhanced Time of Flight (ToF) system . ToF is one of the key components of the H1 experiment. Of paramount importance in the high luminosity of HERA is the availability of time-of-flight signals both close to and away from the electron-proton interaction region. These signals then form the basis, firstly for eliminating background interactions which would otherwise flood the recorded event rate, and secondly for the most accurate determination of the interaction cross sections.

The proposed ToF system will include a number of new detectors to increase the number of timing measurements within the volume of the H1 experiment and to increase the spatial segmentation of present ToF detectors. The aims of the project are

1. to establish the system of ToF detectors, both in the improvements to present detectors, electronics and data acquisition, and the installation of new detectors, electronics and data acquisition,

2. to commission, calibrate and monitor the system for Level 1 on-line use and for off-line use,

3. to develop the off-line analysis codes for the best possible exploitation of ToF data, and thereby for the most accurate measurements of ep interaction cross sections.

The H1 experiment is operated by an international collaboration consisting of 39 institutes from 13 countries. This proposal requests funding for three NIS groups of the H1 experiment to ensure their participation in this time-of-flight project. The proposal will be realized by the groups from following institutions of H1 Collaboration: University of Liverpool (UL, UK), University of Dortmund (UD, Germany), Rutherford Appleton Laboratory (RAL, UK), Yerevan Physics Institute (YerPhI, Armenia), Institute of Theoretical and Experimental Physics, Moscow (ITEP, Russia) and Joint Institute for Nuclear Research, Dubna (JINR, Russia).